

Prevention of Faults on Wool Fabrics by Application of Cold Sizing

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Abstract

Mechanical faults on woolen fabrics are often the result of insufficient mechanical properties of wool warp that must be achieved to ensure smooth process of weaving. Conventional sizing is not appropriate for the preparation of wool yarn for weaving because of sensitivity of wool fibers to high temperatures. For that reason, wool warp is mostly prepared by using the waxing procedure whereby protruding fibers on the yarn surface are smoothed. In this way, its friction and elongation properties are improved. Another option is a cold sizing. It is a process, which aims to achieve the effect of conventional sized warp, but without the use of high temperatures.

Cold sizing has been proved to be a good solution for wool warp sensitive to dynamic stresses during the weaving process. This paper describes advantages of the cold sizing procedure to warp waxing. The number of end breakages on the weaving machine, lengths of a faulty place in the thread marked in the inspection room of the weaving mill, and times spent for manual retouching are compared. The type of fabric, for which an increase in costs for cold sizing is justified, is also determined.

Keywords

Cold Sizing; Worsted Warp Yarn; Waxing

Introduction

In the weaving process, the warp is subjected to various stresses such as cyclic tensioning, bending, friction with machine parts, and thread-to-thread friction during weft beat-up etc. In order for the weaving process to run trouble-free, warp threads should meet certain criteria related to appropriate mechanical properties. First, it applies to strength, friction properties of yarn and elongation properties.

Nowadays, market requirements on fabric manufacturing become increasingly demanding. A demand for woven fabrics with as small masses per unit area as possible increases permanently, resulting in the use of yarns with very fine counts. Thus, criteria

of quality properties of raw materials, yarns and fabrics increase, and technological processes of fabric manufacturing change with these requirements. It is necessary to automate the processing methods so that labor's share is as little as possible. Nevertheless, the operation and development of the automated equipment is impossible without an operator. Furthermore, more comprehensive knowledge and special education of operators and technologists for operating and maintaining the modern equipment are necessary. It is very important to automate warping and sizing machines due to their complexity. This step makes the operation easier and decreases the probability of faults, which cannot be corrected in the downstream manufacturing processes.

To manufacture a qualitative and inexpensive fabric competitive on the market, it is necessary to continually develop new products, design and technology of fabric manufacturing. The investigation aim of this work is to manufacture a qualitative, inexpensive and attractive fabric.

Fabric Faults Caused by Inappropriate Physical Mechanical Properties of the Warp Yarn

The production of fabrics with lower weight necessitates the production of finer and more demanding yarns. Ply yarns with sufficient strength and compactness, ensuring a trouble-free weaving process, replace unconventional single yarns to be used as warp yarns. The cause is an evident difference in the fineness and price of ply and unconventional ring-spun yarn. Although yarn properties have been taken into account in case of developing modified spinning methods, only minimal requirements can be infrequently achieved. Limited values of yarn processability are a frequent cause of disturbances in the fabric production. The replacement of finer ply yarns with single yarns sometimes leads to the reduction of machine efficiency and fabric quality

caused by typical mechanical yarn damages, indicating low mechanical properties.

The most frequent weaving faults are shown in Figures 1 to 4. The fault in Figure 1 occurred because of the non-compactness of the yarn structure, which decreased due to high stresses during weaving and friction against machine elements. Figure 2 shows the warp threads, which is due to too high hairiness caused by the friction against machine elements "caught" each other and switched their places. In yarns with an "opener" structure, too many tiny fibers are removed, and they accumulate on the elements of the weaving machine. The accumulation of lint occurs along the yarn length, mostly between the reed and heald frames. This causes breaks or bits of fibers woven into the fabric, thus faults occur. Stronger thick places are later removed from the fabric, leaving a place with a changed density or even a hole in the fabric "a torn place" (Fig. 3), and if a thick place remains in the fabric as the consequence of a weave structure disorder, there is a risk of fabric damage in the downstream processes (Fig. 4).

Part of these faults is removed in the cloth inspection room, whereby a great deal of skill and manual work is necessary, but there is a risk that the fault is not fully removed.

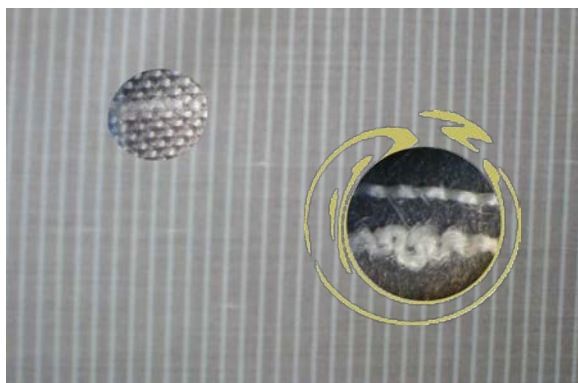


FIG. 1 BROKEN WARP THREAD



FIG. 2 SWITCH OF ADJACENT THREADS IN CASE OF DIFFERENT TWIST DIRECTIONS



FIG. 3 TORN THREAD

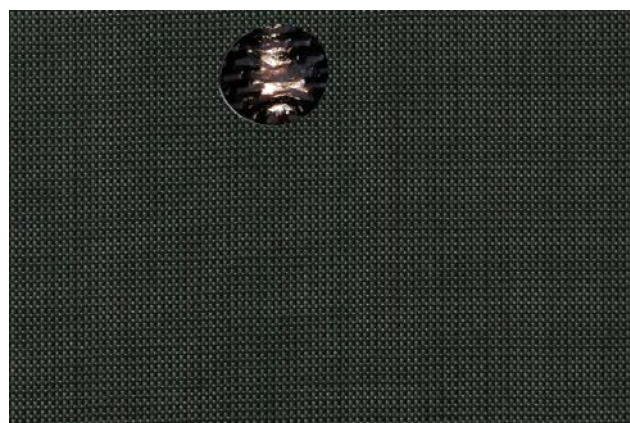


FIG. 4 WEAVE ERROR

Experimental

Yarn processability and efficiency of waxing and sizing wool warp were tested, and the test results were compared. The warp was warped on the section warping machine Benninger BEN TRONIC, and the yarn was from the same batch. About 400 m warp was warped for about 380 m fabric. The first part of the warp (180 m) was waxed with a standard wax agent, while the other part of the warp (220 m) was sized with a cold sizing agent. The conditions of the weaving process were the same (Table 1) on the same Sulzer G 6200 weaving machine.

TABLE 1 FABRIC TECHNICAL SPECIFICATIONS

Fabric width, cm	153
Mass of square meter, g/m ²	170
Number of ends/ 10cm fabric	289
Number of picks/ 10cm fabric	261
Warp width in the reed, cm	177
Number of warp threads	4428
Warp yarn	Wool 15.5X2 tex (Siro) Wool 11x2 tex (Siro) Polyester 8,2x2 tex
Weft yarn	Wool 25 tex (compact)
Raw material composition	99 % fleece wool 1 % polyester

Agents Used for Warp Preparation

1) Warp Waxing

A non-ionizing liquid agent composed of polyglycol ether and fatty alcohol ethoxylate was used for waxing. The agent has antistatic properties; additionally, it is soil resistant and rinsable in the washing process in the wet finishing. The agent is poured into the wax container of the waxing unit. During rewinding from the warp cylinder to the weaver's beam, it is applied directly by the application roller.

2) Cold Sizing

The cold sizing agent is, by its composition, a synthetic copolymer, based on a diluted solution of polyvinyl alcohol (PVA), is water soluble and can be easily rinsed from the fabric using a neutral aqueous solution at the temperature 40°C, as well it is applied very simply when the warp is rewound from the warp cylinder to the weaver's beam, as in case of waxing, without warming and additional drying as in case of conventional sizing. After the application of this agent, the warp threads do not cling to each other and it is not necessary to separate them. The disadvantage of this agent is that it very quickly sediments into the upper liquid layer and the lower gelatinous layer when the container remains open. Therefore, the size should be stirred before it is repeated utilized. The sized warps should not be allowed to rest for a longer period.

Comparison of the Key Parameters of Efficiency and Quality Through the Processing Stages of Fabric Manufacturing

1) Weaving

The number of end breakages on the weaving machine directly depends on the quality of the yarn used for the warp or its mechanical properties. Each break of the warp or weft thread is a potential place of a fault in the fabric; thus, it is desirable to reduce the number of yarn breakages to a minimum. The weaver needs a few minutes to repair a yarn break, which slows down the weaving process.

The fabric was woven on a Sulzer G6200 weaving machine running with a speed of 457 rpm.

Table 2 shows the number of end and picks breakages in case of the waxed and sized warp and

the total number of picks for each individual fabric. Table 3 shows the same values converted into the number of picks per breakage. The difference of the number of picks per one end breakage between the waxed and sized warp is crucial; which is the reason why these data are given in Fig. 5.

TABLE 2 DATA ON THREAD BREAKAGES DURING WEAVING

	Standard waxing agent	Cold sizing agent
Number of picks	308000	346000
Warp yarn breakage	51	24
Weft yarn breakage	40	51
Approximate time of weaving, h	11.25	12.50

TABLE 3 UNIT VALUES OF THREAD BREAKAGES DURING WEAVING

	Standard waxing agent	Cold sizing agent
Number of picks per 1 end breakage	6039	14417
Number of picks per 1 pick breakage	7700	6784

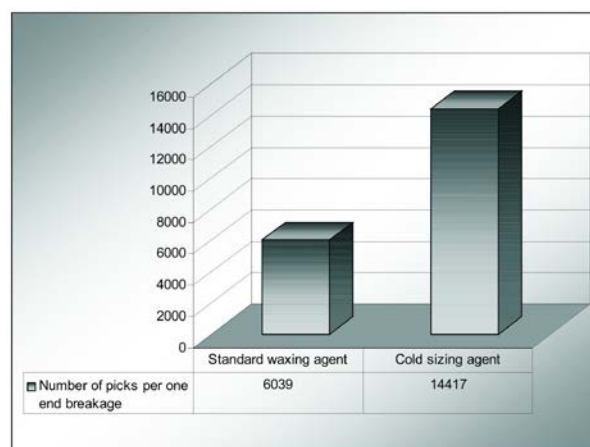


FIG. 5 NUMBER OF END BREAKAGES

2) Exchange of Defective Threads and Cleaning in the Cloth Inspection Room

Exchange of faulty threads (dirty threads, wrong direction of twist, incorrect fineness, wrong raw material composition, color shade etc.), and cleaning in the cloth inspection room is a very slow procedure because a faulty thread in the fabric is removed manually and replaced by a correct one. The cloth inspection room could be a bottleneck of fabric manufacturing, causing late fabric deliveries. Hourly wage and the time necessary to eliminate a certain fault give the price per corrected fault meter. As shown in Table 4, it takes the most time to eliminate faults caused by a warp breakage. Thick and loose threads are caused by an obstructed passage of the thread through

guides, dents and healds in the weaving process where no thread breakage is caused, but it comes to yarn structure deformations and a lack of yarn tension caused by getting stuck against the elements of the warping or weaving machine.

TABLE 4 STANDARD SPECIFICATION IN THE CLOTH INSPECTION ROOM FOR A SPECIFIC FABRIC (NORMATIVES)

Breakages in the warp direction, m/h	1.50
Loose thread, m/h	4.61
Thick places, m/h	4.61

TABLE 5 LENGTH OF INDIVIDUAL FAULT TYPES IN THE FABRIC

	Standard waxing agent	Cold sizing agent
Fabric length (m)	174.8	101.0
Fault length in the warp direction (breakages) (cm)	1070	48
Fault length due to thick threads (cm)	30	0
Fault length due to loose threads (cm)	300	~ 0

In case that the operative can repair and clean one piece of fabric in 1.5 hours, the cloth quality controller is not called to measure faults (the same case happened with the fabrics whose warp sized with a cold sizing agent).

In case of the fabrics sized with a cold sizing agent, no switch of adjacent treads with different twist directions was observed in contrast to the waxed fabrics.

TABLE 6 UNIT VALUES OF FAULT LENGTHS

	Standard waxing agent	Cold sizing agent
Fault length in the warp direction per 1 m of fabric (cm/m)	6.1	0.5
Fault length due to thick threads per 1 m of fabric (cm/m)	0.2	0.0
Fault length due to loose threads per 1 m of fabric (cm/m)	1.7	0.0

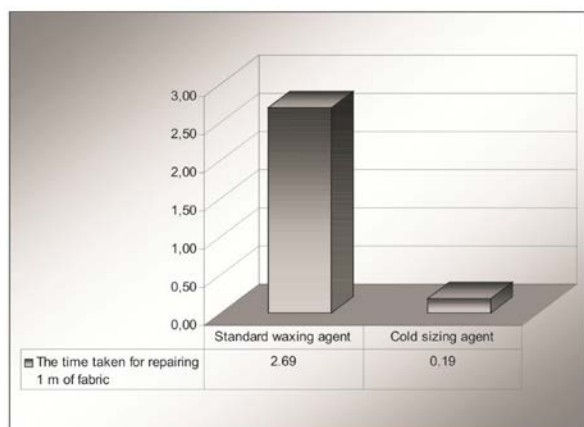


FIG. 6 THE TIME TAKEN FOR REPAIRING 1 M OF FABRIC

3) Manual Retouching

In manual retouching, no differences between the fabrics, woven from the waxed or from the sized warp was observed. A greater portion of faults in the waxed fabric piece which were repaired in the cloth inspection room, managed to "hide" in wet finishing. There was no process neps observed in any fabric piece.

Discussion

In case of the warp waxed with the standard waxing agent, one end breakage occurred per 6039 picks, meaning that there was one machine standstill each 13.2 minutes due to an end breakage (Table 3 and Figure 5). In case of the sized warp, the number of end breakages was significantly lower. One end breakage occurred per 14417 picks, i.e. converted into time, there was a machine standstill each 31.6 minutes due to an end breakage, 2.4 times lower than in case of weaving the waxed warp. If it were considered that it would take the weaver about 3 minutes to eliminate an end breakage and that the working time lasted for 7.5 hours or 450 minutes, in case of the waxed warp, it took the weaver 83.3 minutes to eliminate an end breakages, while in case of the sized warp, it cost 39.0 minutes to eliminate an end breakages. In the latter case, it will not only take less time to eliminate mechanical faults for the respective fabric, which is carried out in the cloth inspection room, but the weaver can be assigned a larger number of weaving machines to operate, capable to produce approximately 2 times more fabric than in the former case. There are no differences in the number of pick breakages, which could be expected since the weft did not undergo any treatment with any agent as well as high stresses, as the case of the warp.

Tables 5 and 6 as well as Fig. 6 show that the exchange of faulty threads and cleaning of 174.8 m and 101.0 m fabric made of the waxed and sized warp cost 470.4 min and 19.2 min, respectively. This means that the exchange of faulty threads and cleaning of 1 m fabric made of the waxed warp needed 2.7 min, while it took 0.2 min to exchange faulty threads and clean the same fabric length for the sized warp, which is 13.5 times less.

In manual retouching, after the wet treatment, no difference was observed between the fabric wovens from the waxed warp and the sized warp, respectively. This means that this fabric style has appropriate construction characteristics, and the corrected faults

fitted into the fabric structure are invisible.

Conclusion

The warping, the key process prior to weaving depends on quality of fabric production in further processing stages. Faults that occur during sizing are almost incorrigible in the downstream processes. Thus, warping is one of very important stages in fabric manufacturing confirmed by a sentence "well prepared is half woven". Sectional warping is among other things used for wool yarns which have usually been waxed and not sized up to now. Nevertheless, cold sizing is required due to market demands for higher quality and more lightweight fabrics. Waxing does not satisfy new products and cold sizing is applied.

This paper proves the justification of using cold sizing for lightweight wool fabrics made of finer warp ply yarns. By sizing, the efficiency of weaving machines has increased, enabling a higher machine assignment per operator. Likewise, the productivity of the operator cleaning grey cloths increases too. Switching from waxing to sizing the warp does not mean that the sectional warper should be rebuilt. Thus, the same sectional warper can be used either for waxing or for cold sizing, depending on individual fabric styles. Further research is necessary to optimize cold size pick-up based on size recipes and selection of sizing agents.

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